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U. S. DEPARTMENT OF AGRICULTURE

# Oaks (Eastern)

## (*Quercus* species)

By H. S. Betts, *formerly senior engineer, Division of Forest Products*[1]

The oaks are the most important hardwood group in the United States because of the quantity of oak timber available, the strength and beauty of the wood, and its fitness for a wide range of uses. In quantity of standing timber, the oak group leads the hardwoods but is considerably below several of the conifers.

The native oaks, nearly 60 tree species and several shrubby ones, are found in every State but Idaho. Twenty species growing east of the Rocky Mountains and at least 3 species of the Pacific Coast States may be classed as commercially important. In the lumber trade, oaks are divided into two groups, "red oak" and "white oak," and the different species usually are distinguished only according to the group to which they belong. The wood of the white oaks generally lacks the reddish tinge common in the red oaks, and the pores in the heartwood of nearly all the white oaks are filled with a natural membranous growth which makes the wood less permeable to liquids and more resistant to decay.

Oak is the leading wood for flooring, barrels and kegs, and railroad ties. It is used extensively for interior finish, furniture, veneers, vehicle parts, ships and boats, boxes and crates, pallets, fuel, and mine timbers.

Oak has ranked fourth in lumber production among all woods for many years and first among hardwoods. A downward trend in the production of oak lumber from 1909 to 1941 was partly due to the substitution of other materials or woods for oak and the increasing difficulty in getting high-grade oak. Production in 1941 was considerably greater than in 1940; in 1942 it was nearly double that in 1940. This was due undoubtedly to demands brought about by war. The 10-year period from 1945 to 1954 was marked by a generally increasing trend in production. In recent years the States in the Deep South, where the largest remaining oak stands of sawtimber size are located, have supplied a greater proportion of the oak lumber than formerly.

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[1] Revised by Division of Forest Products Research, Forest Service, Washington, D.C., and Forest Products Laboratory, Forest Service, Madison, Wis. Mr. Betts retired in January 1945.

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**Nomenclature.**—The common and scientific names designated by the U.S. Forest Service [2] for the important commercial species of red and white oaks are listed below. Practically all of these species are known locally by other names also.

| *Common name* | *Scientific name* |
|---|---|
| Red oak group: | |
| Black oak | *Quercus velutina* |
| Blackjack oak | *Q. marilandica* |
| Cherrybark oak | *Q. falcata* var. *pagodaefolia* |
| Laurel oak | *Q. laurifolia* |
| Northern red oak | *Q. rubra* |
| Nuttall oak | *Q. nuttallii* |
| Pin oak | *Q. palustris* |
| Scarlet oak | *Q. coccinea* |
| Shumard oak | *Q. shumardii* |
| Southern red oak | *Q. falcata* var. *falcata* |
| Water oak | *Q. nigra* |
| Willow oak | *Q. phellos* |
| White oak group: | |
| Bur oak | *Q. macrocarpa* |
| Chestnut oak | *Q. prinus* |
| Chinkapin oak | *Q. muehlenbergii* |
| Live oak | *Q. virginiana* |
| Overcup oak | *Q. lyrata* |
| Post oak | *Q. stellata* |
| Swamp chestnut oak | *Q. michauxii* |
| Swamp white oak | *Q. bicolor* |
| White oak | *Q. alba* |

**Distribution.**—Oaks are widely distributed in eastern United States from Maine to Florida west to Minnesota and Texas and form an important part of the eastern hardwood or deciduous forests. Though many species have their western limits at or near the prairies, bur oak ranges beyond to eastern Montana and Wyoming. There are more kinds of oaks in the Southeast than in the Northeast. Eighteen of the species listed are found in Tennessee and North Carolina.

## RED OAK GROUP

Eleven species of eastern red oak are important commercially. More than one-half of the oak lumber originates from these species. The species most widely distributed are blackjack oak, black oak, northern red oak, Shumard oak and southern red oak (including cherrybark oak). Other species are of local or regional importance.

Red oak sapwood is nearly white and 1 to 2 inches thick. Heartwood is brown with a tinge of red. Lumber sawed from red oak trees cannot be separated by species on the basis of wood characteristics alone. However, red oak lumber can be separated from white oak lumber; the wood is red oak if the pores in the summerwood of a smoothly cut end surface can be readily counted when viewed through a hand lens. As a rule, red oak lacks tyloses in the pores. The open pores of red oak make it unsuitable for tight cooperage. Red oak wood is heavy. Second-growth oak is generally harder and tougher than finer textured old-growth timber. The wood shrinks considerably as it dries.

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[2] U.S. Forest Service, CHECK LIST OF NATIVE AND NATURALIZED TREES OF THE UNITED STATES (INCLUDING ALASKA). U.S. Dept. of Agriculture, Agriculture Handbook No. 41, 1953.

**Northern red oak** is noted for its high-quality lumber. This species is found from Maine to Minnesota and south to Oklahoma and Georgia (fig. 1). West Virginia probably contains the largest stands of sawtimber size, followed by North Carolina and Tennessee. Mature trees are generally 70 to 80 feet high and about 2 feet in diameter. Second-growth red oak averages somewhat heavier than old growth.

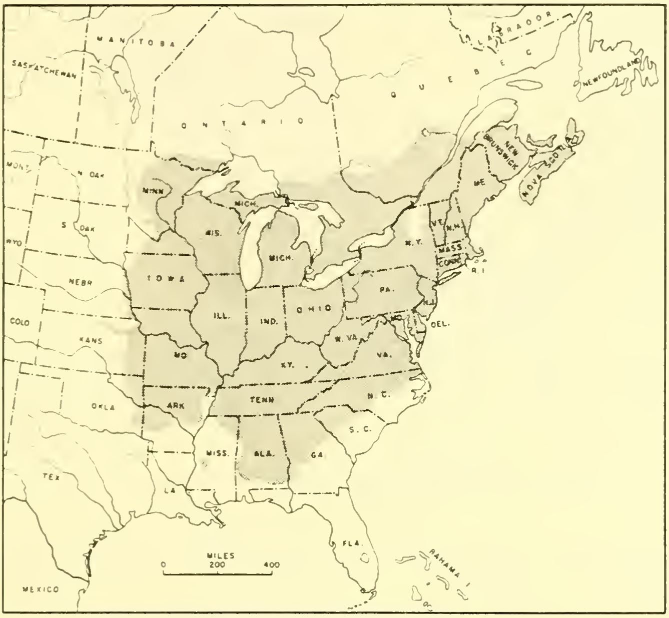

FIGURE 1.—Range of northern red oak (*Quercus rubra*).

**Scarlet oak** grows from southwest Maine west to Indiana, southeastern Illinois, and southeastern Missouri and southward to Alabama and Georgia (fig. 2). It is most abundant in Pennsylvania, Ohio, and West Virginia. Since it is found principally on poor soils, the lumber is generally of lower quality than that of northern red oak. On favorable soils, however, the lumber is often of good quality. Mature trees are 70 to 80 feet high and 2 to 3 feet in diameter.

**Shumard oak** is found mainly in the Coastal Plain from North Carolina to Florida and Texas, and north in the Mississippi Valley to Missouri and Indiana. It also occurs locally beyond to Ohio and Pennsylvania (fig. 3). It grows generally in wet bottom lands along the borders of streams and swamps. Under favorable conditions, trees reach a diameter of 4 feet and a height of 100 feet. The heavily buttressed trunk is often free of branches for 50 feet; it yields lumber of high quality. Shumard oak is most abundant and reaches its largest size in the bottom lands of the Mississippi basin. The timber is of good average quality; it is closely utilized, principally for furniture, cabinet work, and veneer. The tree has no particular defects or enemies.

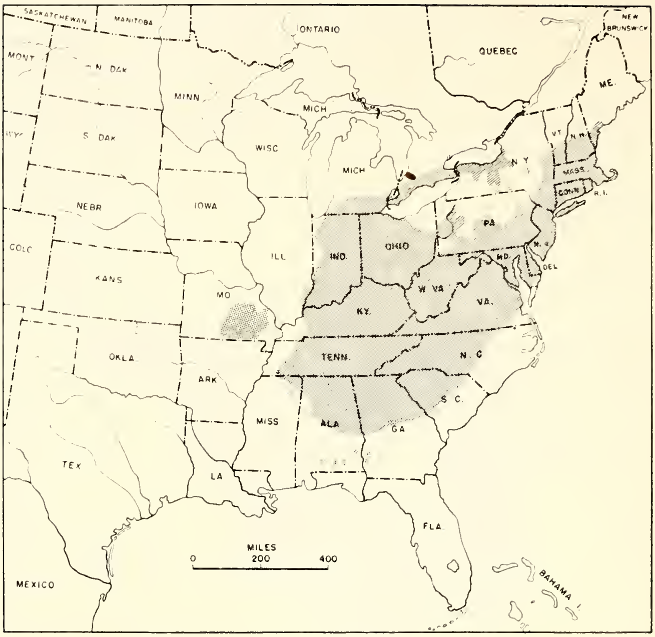

FIGURE 2.—Range of scarlet oak (*Quercus coccinea*).

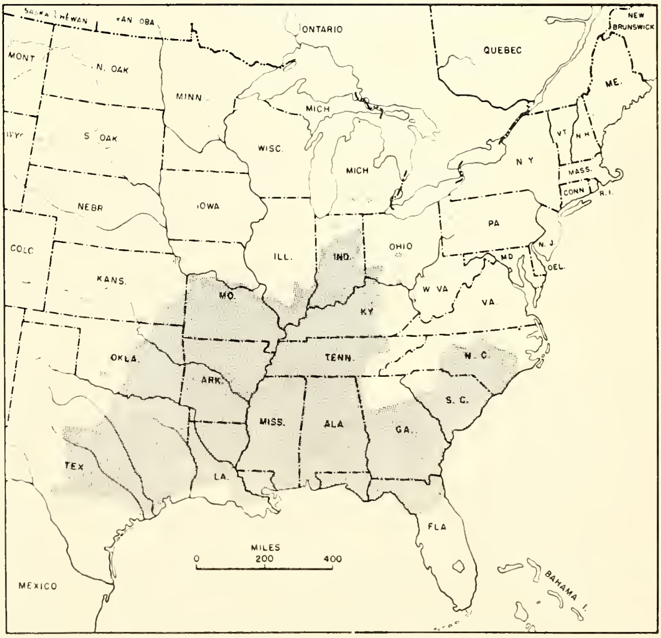

FIGURE 3.—Range of Shumard oak (*Quercus shumardii*).

**Pin oak** is found mostly in the east central States, from Massachusetts and southern New York west to Illinois and eastern Kansas, south to northeastern Oklahoma and South Carolina (fig. 4). It is a large tree and inhabits wet areas along streams and swamps. Under favorable conditions, trees may reach a height of 80 to 100 feet and a diameter of 2 to 3 feet. Pin oak is not of great importance for lumber but is used for fuel, charcoal, and distillation products; it is also used as a shade tree.

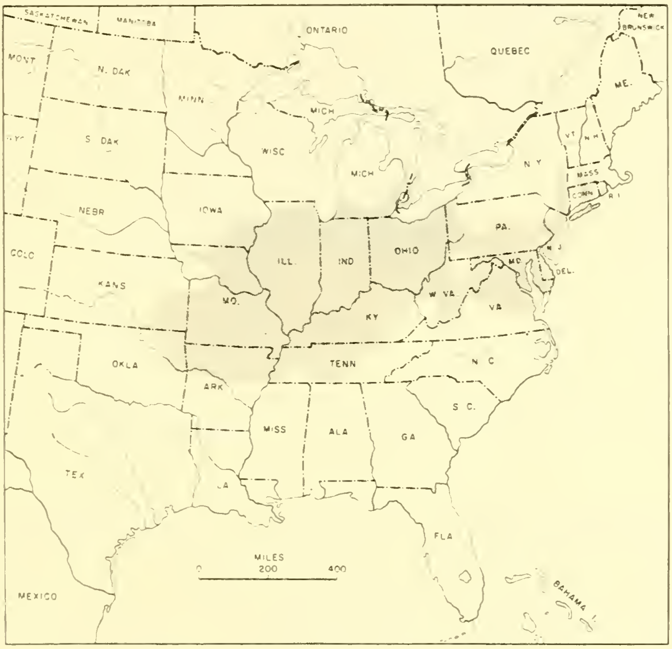

FIGURE 4.—Range of pin oak (*Quercus palustris*).

**Nuttall oak** grows in the Coastal Plain and the lower Mississippi Valley from Alabama and western Tennessee to Arkansas and eastern Texas (fig. 5). It is a fairly large tree and supplies lumber of good quality. In some regions it is of considerable commercial importance.

**Black oak** is widely distributed from Maine to Minnesota, south to eastern Texas and Florida (fig. 6). The largest supplies are in Tennessee, Arkansas, Kentucky, and Missouri. While the stand of black oak is large and some fine timber is produced under favorable conditions, much of it occurs on poor soils so that the trees are scrubby and too small or too poor in quality for sawtimber. Black oak bark contains tannin and a material useful in the dye industry. Under favorable conditions, black oak trees reach a height of 70 to 80 feet and a diameter of 2 to 3 feet.

**Southern red oak, including the variety cherrybark oak** is found mainly in the Coastal Plain from New Jersey to Florida and eastern Texas, and north in the Mississippi Valley to southern Missouri and southern Indiana (figs. 7, 8). However, the typical variety of south-

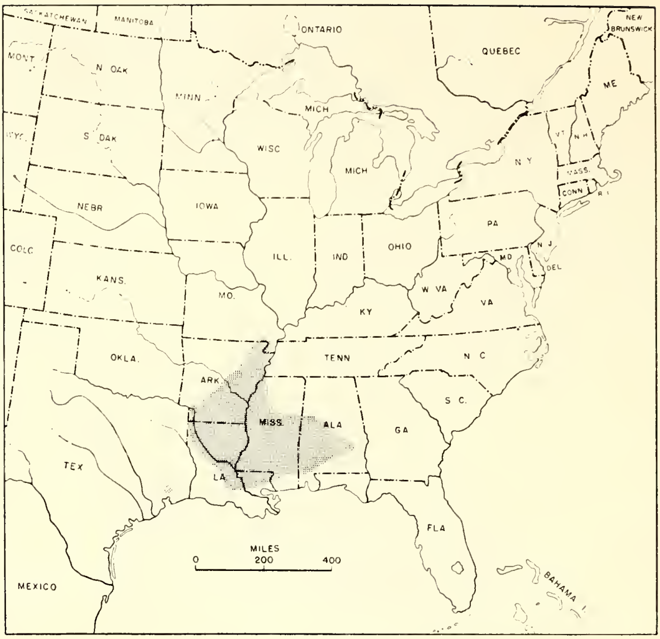

FIGURE 5.—Range of Nuttall oak (*Quercus nuttallii*).

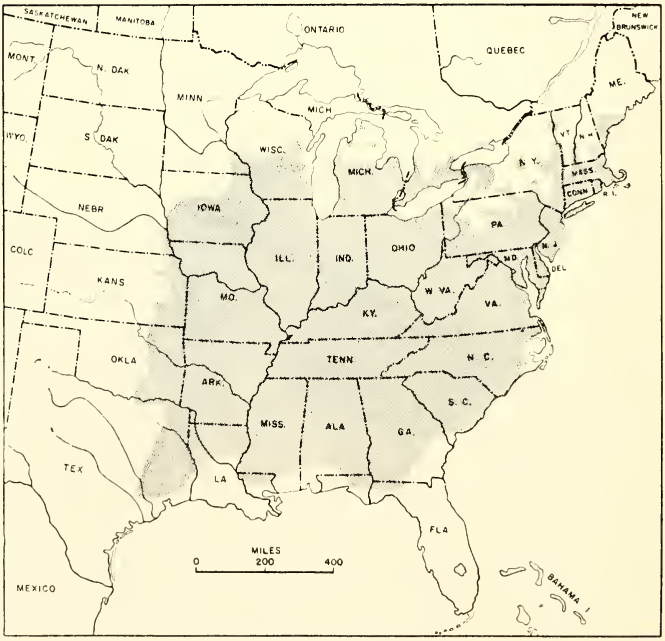

FIGURE 6.—Range of black oak (*Quercus velutina*).

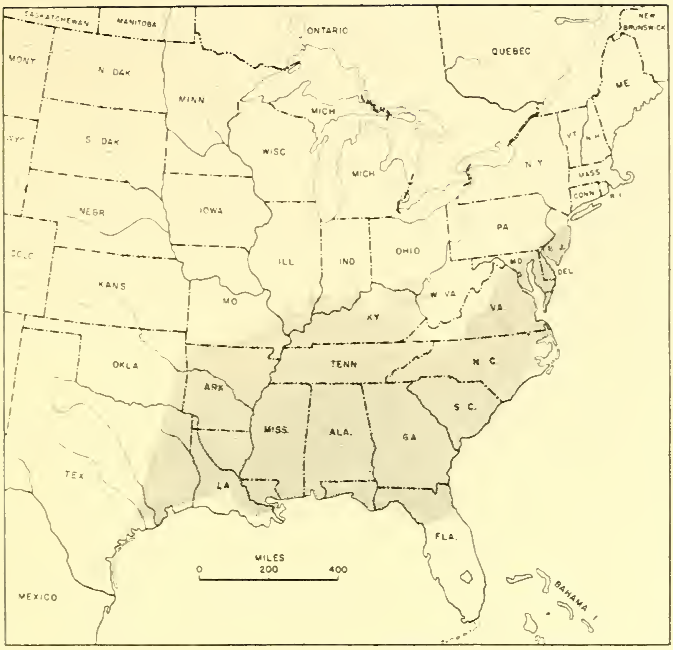

Figure 7.—Range of southern red oak (*Quercus falcata* var. *falcata*).

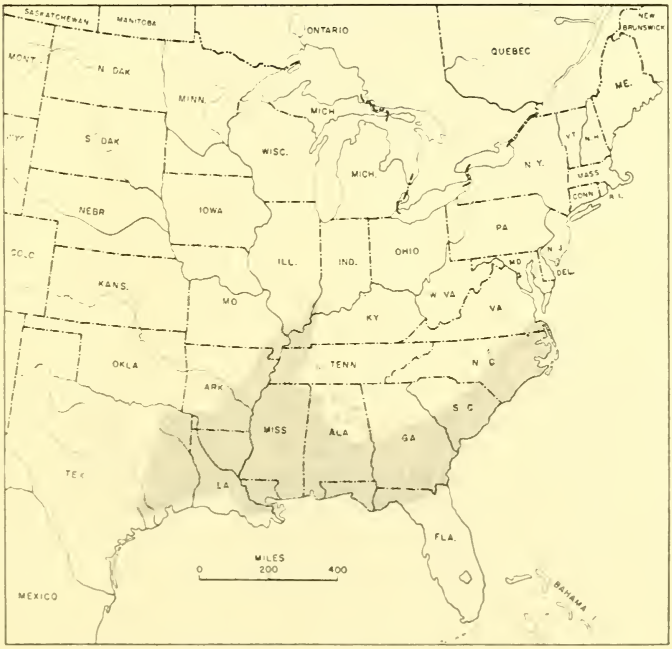

Figure 8.—Range of cherrybark oak (*Quercus falcata* var. *pagodaefolia*).

ern red oak has a broader range northward to Long Island, southeastern Pennsylvania, and southern Ohio. The largest supplies are found in Arkansas and Louisiana. Southern red oak trees generally reach diameters of 2 to 3 feet and heights of 70 to 80 feet. Cherrybark oak trees grow to somewhat larger sizes and produce a larger proportion of high-grade lumber than do southern red oaks.

**Blackjack oak** grows in dry sandy barrens, under conditions that most trees cannot endure. It is widely distributed from Long Island and New Jersey west to southern Iowa and eastern Kansas and south to Texas and Florida (fig. 9). Trees of saw-log size are rare. The wood is used for fuel, charcoal, distillation, and fiber products. Blackjack oak can be used for fence posts if it is given preservative treatment.

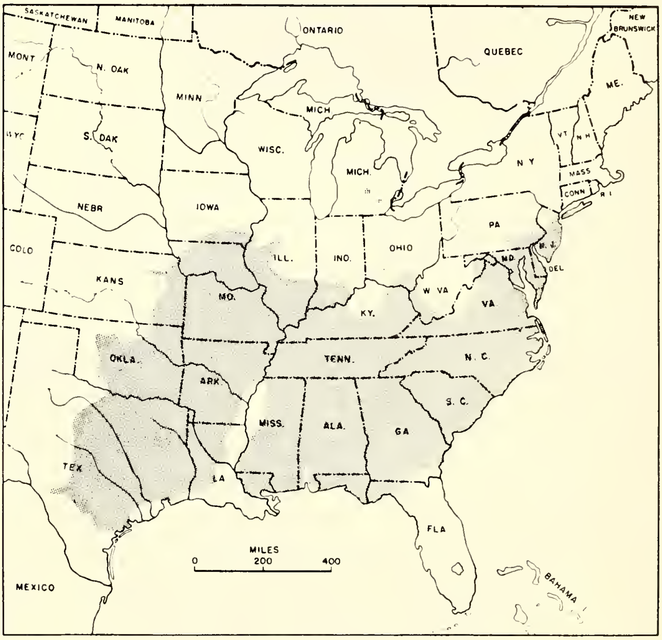

FIGURE 9.—Range of blackjack oak (*Quercus marilandica*).

**Water oak, laurel oak,** and **willow oak** grow in the Coastal Plains from New Jersey to Florida and eastern Texas (figs. 10, 11, 12). Water oak and willow oak range northward in the Mississippi Valley to southeastern Missouri; the latter also to southern Illinois and western Kentucky. Trees of these species live on the borders of streams and swamps. The lumber supplies of water oak and willow oak are found largely in Arkansas, Louisiana, Mississippi, and Texas. The trees reach heights of 80 to 90 feet and diameters of 2 to 3 feet. Pin knots are common in willow oak. Laurel oak is not important as a timber tree, but it is used for fuel, charcoal, distillation products, and as a shade tree.

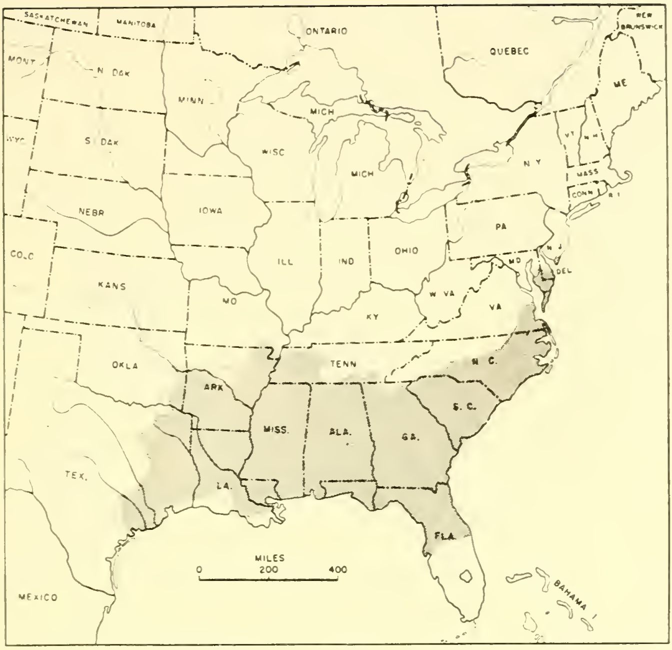

Figure 10.—Range of water oak (*Quercus nigra*).

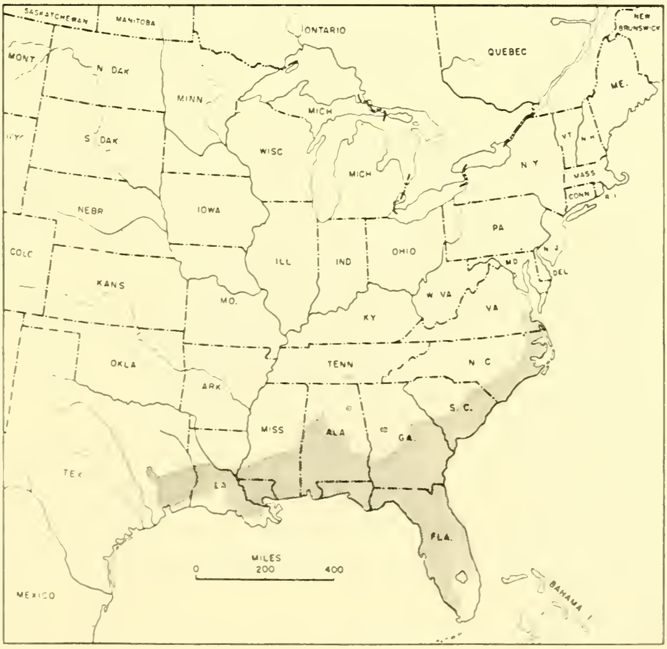

Figure 11.—Range of laurel oak (*Quercus laurifolia*).

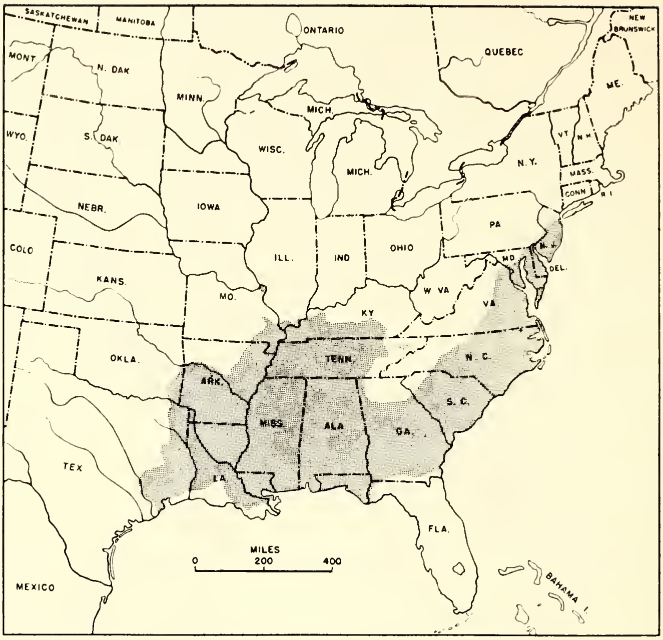

FIGURE 12.—Range of willow oak (*Quercus phellos*).

## WHITE OAK GROUP

In the eastern United States nine species of the white oak group have commercial importance. Those of widest distribution are bur oak, white oak, post oak, and chinkapin oak. Ranges of the others are more limited.

Wood of the white oaks is heavy, averaging somewhat higher in weight than that of the red oaks. White oak heartwood has moderately good decay resistance. The pores of the heartwood usually are plugged with a natural growth of parenchyma cells, known as tyloses, which makes the wood impenetrable by liquids. However, chestnut oak lacks tyloses in many of its pores.

To distinguish wood of the white oak species from that of the red oaks, examine a smoothly cut end surface through a hand lens. If the pores of the summerwood are very small, somewhat angular, and so numerous that it would be extremely difficult to count them, the wood belongs to the white oak group.

**Live oak,** which is an evergreen species, grows mostly in a narrow belt along the coast from southeastern Virginia to Florida and Texas, where it extends into the interior (fig. 13). It is not important commercially for lumber because its short trunk divides into large, horizontally spreading branches. Formerly, it was used for "knees" in ships. Live oak is planted as an ornamental tree in the Southern States. The wood is the heaviest, strongest, and hardest of the oaks. Seasoning is difficult.

**Chinkapin oak** ranges from Vermont west to southern Wisconsin and southeastern Nebraska, south to Texas and Florida (fig. 14). Also, it is found locally in southeastern New Mexico and northeastern

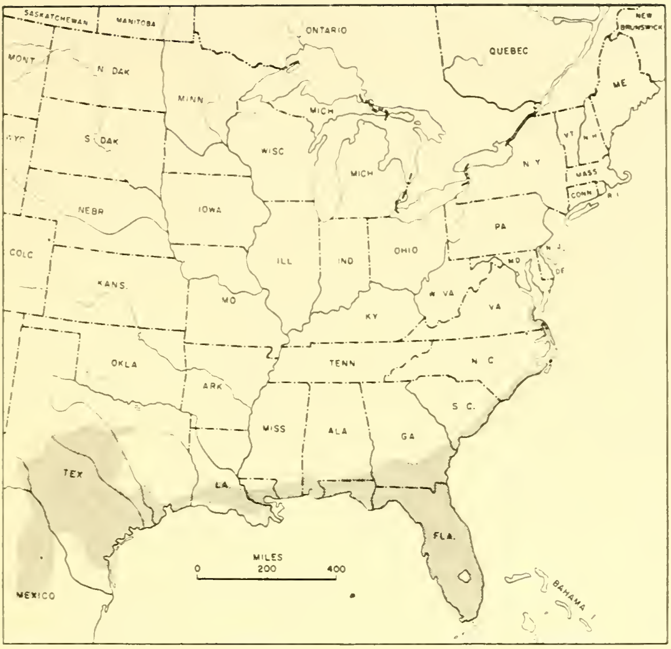

FIGURE 13.—Range of live oak (*Quercus virginiana*).

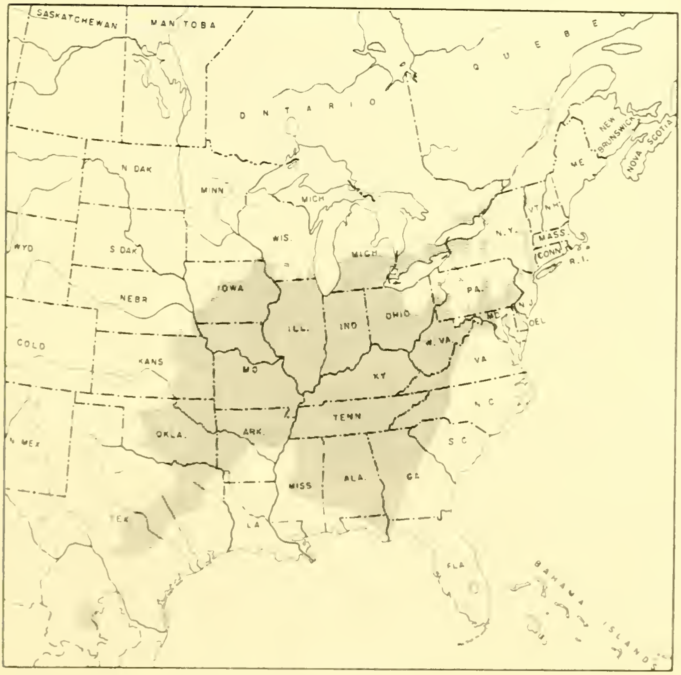

FIGURE 14.—Range of chinkapin oak (*Quercus muehlenbergii*).

Mexico. It is usually of secondary importance and is used mainly for ties and timbers for rough construction. Mature trees are generally 18 to 20 inches in diameter and 60 to 90 feet high. Old-growth trees, particularly in southern Indiana and Illinois, were much larger.

**Chestnut oak** has a comparatively restricted range, from southwestern Maine west to southern Indiana and southern Illinois and southward to northeastern Mississippi and northern Georgia (fig. 15). Members of this species live mainly on upper slopes and ridges; the trees attain diameters of 10 to 20 inches and are suitable for ties or rough lumber for construction. On better sites, mature trees reach diameters of 20 to 30 inches and heights of 70 to 80 feet. They supply good saw material and are sold as white oak. This species is unsuited for tight cooperage. Second-growth trees surpass old growth in specific gravity by an average of 14 percent, and in growth rate by 60 percent. The bark of chestnut oak, containing tannin, once had considerable commercial use; recently, only small quantities have been utilized.

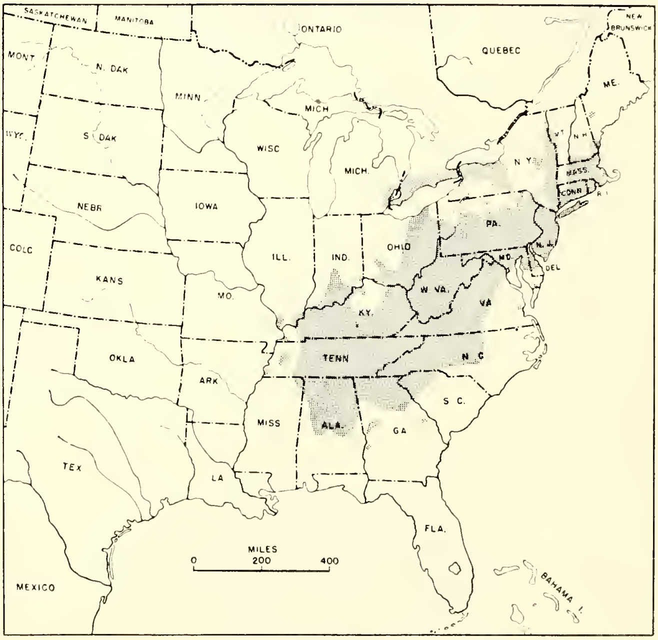

FIGURE 15.—Range of chestnut oak (*Quercus prinus*).

**Swamp chestnut oak** grows in the Coastal Plain from New Jersey to Florida and eastern Texas, and north in the Mississippi Valley to Illinois and southwestern Ohio (fig. 16). It is a tree of moderate to large size and frequently develops a massive, straight trunk. Old-growth trees reached diameters of 3 to 7 feet and a height of 100 feet. Swamp chestnut oak has long been one of the most important hardwoods of the Mississippi River delta region. The supply has been considerably reduced by heavy cutting.

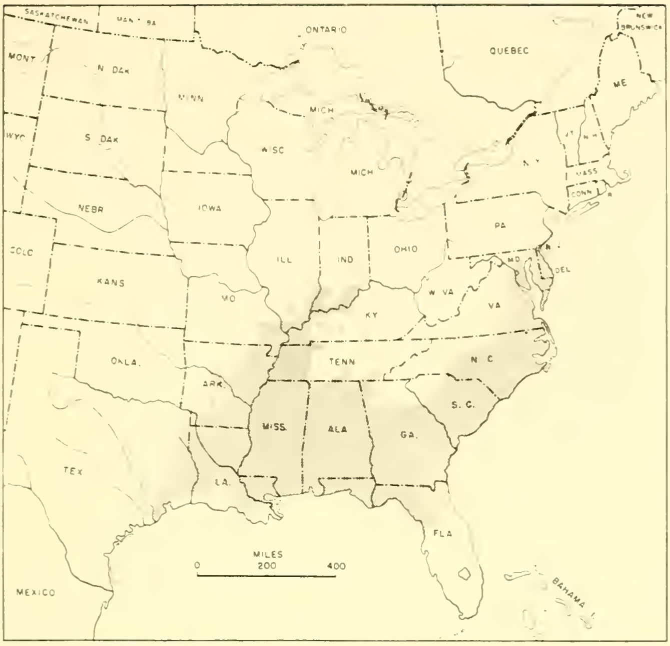

Figure 16.—Range of swamp chestnut oak (*Quercus michauxii*).

**Swamp white oak** grows in limited amounts on bottom lands of the Northeastern and Central States from southwestern Maine west to southeastern Minnesota and south to Missouri and North Carolina (fig. 17). Trees may reach a diameter of 3 feet and a height of 80 feet. The wood compares favorably with the best white oak.

**Bur oak** is widely distributed from Maine west to North Dakota, southeastern Montana and northeastern Wyoming, south to Texas and Maryland. Its range extends farthest west of the eastern oaks (fig. 18.) Under favorable conditions, bur oak trees sometimes reach a diameter of 6 feet and a height of 160 feet. Mature trees average 2 to 3 feet in diameter and 80 to 90 feet high. They frequently have straight trunks that are clear of branches. Data, from one locality only, indicate the weight and strength of the wood to be somewhat below that of white oak.

**Overcup oak** grows in the Coastal Plain from New Jersey to Florida and eastern Texas and north in the Mississippi Valley to southern Illinois and southwestern Indiana (fig. 19). Overcup oak trees rarely reach a diameter of more than 3 feet. The species often has a short, crooked trunk and is very susceptible to attack by insects. In spite of these defects, many trees yield merchantable logs. The wood has a decided tendency to check and warp as it is seasoned.

**Post oak** grows from southern Massachusetts west to southern Iowa and eastern Kansas and south to Texas and Florida (fig. 20). Because of its usually short and limby trunk, it is used mainly for ties and construction timbers. Frequently attacked by borers, many of these trees are made unfit for lumber. Mature trees generally are 1

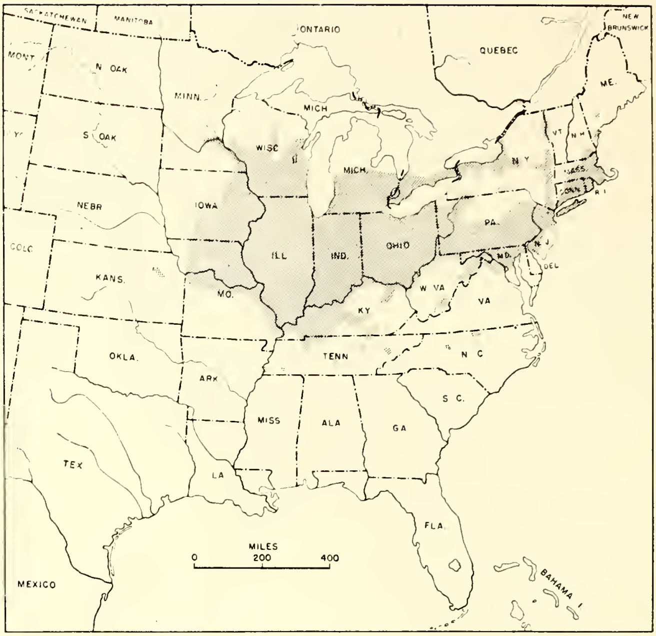

Figure 17.—Range of swamp white oak (*Quercus bicolor*).

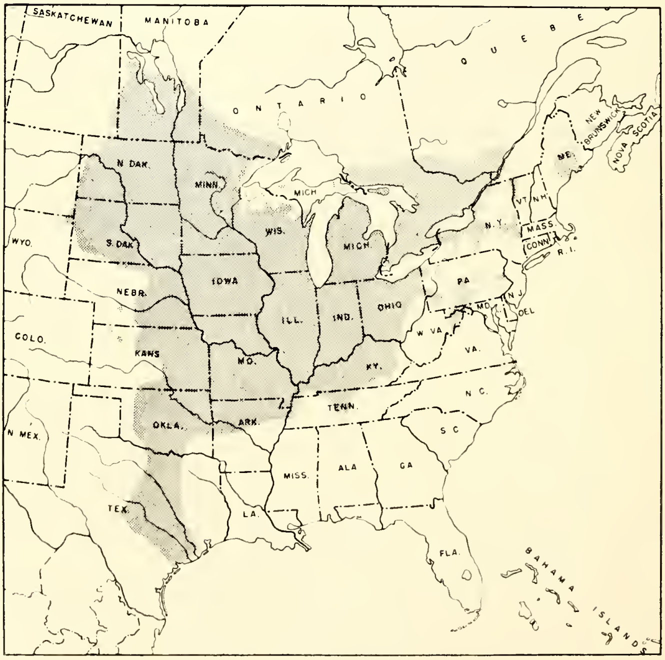

Figure 18.—Range of bur oak (*Quercus macrocarpa*).

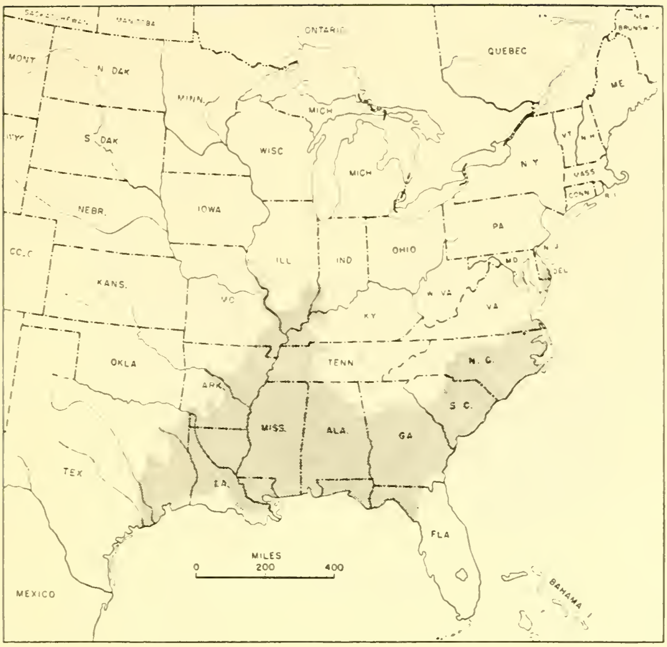

Figure 19.—Range of overcup oak (*Quercus lyrata*).

to 2 feet in diameter and 50 to 60 feet tall. The variety known as Delta post oak (*Quercus stellata* var. *mississippiensis*) is one of the important hardwoods in the lower Mississippi Valley bottom lands of western Mississippi, southeastern Arkansas, and eastern Louisiana.

**White oak** has a wide range from Maine to Minnesota, south to eastern Texas and Florida (fig. 21). It formerly occupied extensive areas of rich arable land in the group of States bordering Kentucky. Trees 400 years old, 6 feet in diameter, and 130 feet high were not uncommon. Now, forest trees 3 feet in diameter are rare. The dominance of white oak was due to its longevity and persistence of growth rather than to prolific reproduction or rapidity of growth. White oak is largely responsible for the reputation of oak as a high-grade, all-purpose wood. It has proved valuable in use because of its strength, hardness, toughness, shrinkage behavior, durability, and beauty of grain. Logging and cutting practices have tended to decrease the proportion of white oak in second-growth hardwood stands and to favor more rapidly growing species. Tests of wood from a number of second-growth white oak stands indicate an average increase in specific gravity of about 9 percent over that of old-growth timber. Average ring width of second-growth white oak was about 160 percent of old growth.

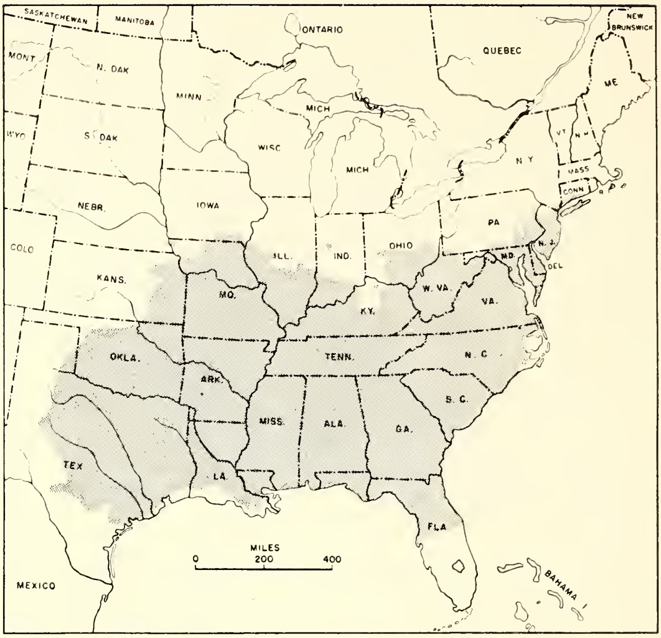

Figure 20.—Range of post oak (*Quercus stellata*).

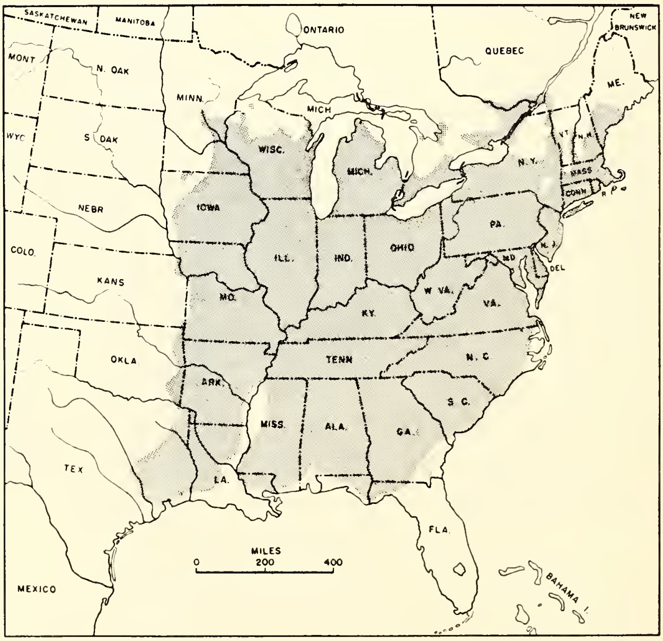

Figure 21.—Range of white oak (*Quercus alba*).

## SUPPLY

The total stand of oak of sawtimber size in the United States was estimated at 146 billion board feet in 1953.[3] Oaks thus account for about 36 percent of the total stand of hardwood sawtimber in the nation.

Estimates of the distribution of oak sawtimber by regions and the proportions of white and red oak groups in each are shown in table 1.

The total stand of the commercial red oaks is somewhat larger than that of the white oaks. The difference will probably become more marked in the future, since the white oaks are preferred for most purposes. Black oak leads among the commercial red oaks, but much of it is unsuitable for sawtimber; despite its larger stand, it is considerably less important than northern red oak as a source of oak lumber. White oak makes up approximately 45 percent of the stand of the white oak group.

The largest supplies of oak, especially old-growth timber, are found in the middle South and Southern States. The delta regions of Louisiana, Arkansas, and Mississippi contain about 24 billion board feet while Virginia, West Virginia, and Kentucky in the Appalachian area have about 31 billion board feet. As the old-growth timber in the South is cut, the second-growth material there and in the more northern regions will assume increasing importance. Forest survey data indicate that about one-fourth of the sawtimber in the Deep South can be classed as high-grade material.

Table 1.—*Estimated stand of oak sawtimber in eastern United States by regions and States and approximate proportions of white oaks and red oaks, Jan. 1, 1953*[1]

| Region | Stand | Proportion of stand | |
|---|---|---|---|
| | | White oaks | Red oaks |
| Northeast: | *Million* | | |
| New England: | *bd. ft.* | *Percent* | *Percent* |
| Maine | 173 | | |
| New Hampshire | 417 | | |
| Vermont | 210 | | |
| Massachusetts | 608 | | |
| Rhode Island | 103 | | |
| Connecticut | 1, 007 | | |
| Middle Atlantic: | | | |
| New York | 2, 627 | | |
| New Jersey | 728 | | |
| Pennsylvania | 8, 164 | | |
| Delaware | 403 | | |
| Maryland | 2, 439 | | |
| Total | 16, 879 | 40 | 60 |

See footnote at end of table.

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[3] U.S. Forest Service, TIMBER RESOURCES FOR AMERICA'S FUTURE, U.S. Dept. Agr., Forest Resource Report 14, 713 pp., illus. 1958.

Table 1.—*Estimated stand of oak sawtimber in eastern United States by regions and States and approximate proportions of white oaks and red oaks, Jan. 1, 1953* [1]—Continued

| Region | Stand | Proportion of stand | |
|---|---|---|---|
| | | White oaks | Red oaks |
| Lake: | *Million bd. ft.* | *Percent* | *Percent* |
| Michigan | 2, 843 | | |
| Wisconsin | 4, 719 | | |
| Minnesota | 1, 932 | | |
| Total | 9, 494 | 33 | 67 |
| Central: | | | |
| Ohio | 5, 609 | | |
| Indiana | 4, 513 | | |
| Illinois | 6, 593 | | |
| Missouri | 8, 359 | | |
| Iowa | 1, 196 | | |
| Total | 26, 270 | 47 | 53 |
| South: | | | |
| Deep South: | | | |
| South Carolina | 3, 174 | | |
| Georgia | 4, 830 | | |
| Florida | 1, 216 | | |
| Alabama | 6, 227 | | |
| Mississippi | 5, 834 | | |
| Louisiana | 6, 925 | | |
| Arkansas | 11, 084 | | |
| Oklahoma | 2, 178 | | |
| Texas | 4, 240 | | |
| Total | 45, 708 | 40 | 60 |
| Middle South: | | | |
| North Carolina | 8, 633 | | |
| Virginia | 10, 388 | | |
| West Virginia | 7, 972 | | |
| Kentucky | 12, 906 | | |
| Tennessee | 6, 838 | | |
| Total | 46, 737 | 47 | 53 |
| Plains | 1, 301 | | |
| All Regions | 146, 389 | 43 | 57 |

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[1] Adapted from U.S. Forest Service, TIMBER RESOURCES FOR AMERICA'S FUTURE. U.S. Dept. Agr. Forest Resource Report 14. Appendix, table 7, p. 512. 1958.

## PROPERTIES AND USES

**Properties.**—The heartwood of the white oaks is generally grayish brown with no reddish tinge, and that of the red oaks is brown with a tinge of red. Sapwood is lighter in color than heartwood in both the white and red oaks of sawtimber size and varies from one to several inches in width. The annual growth rings on a cross section of oak are distinct. Each ring is made up of a band of dense summerwood and a band of lighter colored springwood that contains large pores. In the white oaks, the pores of the heartwood are usually plugged with frothlike growths known as tyloses.[5] In the red oaks, the pores are generally open and provide channels for the ready penetration of liquids. While the wood of the white oaks can be distinguished from that of the red oaks, there is no reliable method of distinguishing between the woods within either group. Oak wood has a striking appearance because of the broad and conspicuous rays that show distinctly in quarter-sawed material.[6]

In general, the wood is heavy, hard, stiff, and strong and has high ability to resist shock (table 2). Tests indicate that the white oaks, as a group, are about equal in strength to the group of red oaks.

TABLE 2.—*Average weights of old-growth and second-growth red oaks and white oaks*

| Red oak group | | | White oak group | | |
|---|---|---|---|---|---|
| Species | Old-growth | Second-growth | Species | Old-growth | Second-growth |
| | *Lb. per cu. ft.*[1] | *Lb. per cu. ft.*[1] | | *Lb. per cu. ft.*[1] | *Lb. per cu. ft.*[1] |
| Black oak | 44 | 47 | Bur oak | 44 | -------- |
| Blackjack oak | -------- | 50 | Chestnut oak | 44 | 52 |
| Cherrybark oak | 47 | 49 | Live oak | 63 | -------- |
| Laurel oak | 45 | -------- | Overcup oak | 44 | 44 |
| Northern red oak | 43 | 45 | Post oak | 48 | -------- |
| Nuttall oak | 43 | 45 | Swamp chestnut oak | 48 | -------- |
| Pin oak | -------- | 44 | Swamp white oak | 51 | -------- |
| Scarlet oak | -------- | 45 | White oak | 47 | 50 |
| Southern red oak | 41 | 45 | | | |
| Water oak | 44 | 46 | | | |
| Willow oak | 44 | 47 | | | |

[1] At 12 percent moisture content.

Second-growth oak is generally stronger, harder, and tougher than old-growth timber; the latter is finer grained, softer, more easily worked, and takes a finer finish. Strength properties of live oak rank considerably higher than those of the other oaks. Oak shrinks a great deal as it dries, so that seasoning must be done carefully to avoid checks and warp.

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[5] Chestnut oak is an exception. Only an occasional closed or partly closed pore is found in this wood.

[6] Rays are narrow bands of cells that grow radially within the tree. They may be likened to double-edged knife blades that thrust toward the center of the tree so as to crowd between the vertical cells.

The average weight of old-growth timber of the white oak group is about 47 pounds per cubic foot at 12 percent moisture content. Live oak is not included in this average, as it is markedly heavier than the other oaks and is little used for lumber. The average weight of old growth of the red oak group is 44 pounds per cubic foot; second-growth material ranges from about 5 to 10 percent heavier (table 2).

In machining properties, the oaks have a high rank, as indicated in table 3. In all operations except shaping, both the white oaks and red oaks are considerably above the average of 25 hardwoods tested. In shaping, one of the most exacting operations, the white oaks were slightly above the average, and the red oaks slightly below.

TABLE 3.—*Percentage of pieces in good to excellent condition after machining operations*

| Kinds of wood | Planing | Shaping | Turning | Boring | Mortising | Sanding | Steam bending |
|---|---|---|---|---|---|---|---|
| | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* | *Percent* |
| White oaks | 84 | 28 | 85 | 95 | 100 | 83 | 91 |
| Red oaks | 91 | 21 | 84 | 99 | 100 | 81 | 86 |
| Average of 25 species of hardwoods | 61 | 25 | 79 | 89 | 70 | 45 | 62 |

In resistance to decay,[7] the white oaks are classed as intermediate, together with dense southern pine and dense Douglas-fir, and placed in the second of five groups of woods arranged in the order of their durability. The less durable red oaks are classed with yellow birch, sugar maple, and the spruces in next to the lowest of the five groups. Oak is capable of taking a wide range of finishes, varying from the garish "golden oak," common 50 years ago, to the quiet brown finishes now frequently used.

The bark of several of the oaks, especially chestnut oak and black oak,[8] contains a comparatively high percentage of tannin, which can be used in the treatment (tanning) of animal skins to make them strong, flexible, water resistant, and lasting.

When oak wood is heated in closed retorts or ovens in the absence of air (distillation process), charcoal and certain other products are formed. When subjected to further processes, these products yield wood alcohol (methanol) and acetic acid.

**Principal uses.**—Oak is used principally for lumber, veneer, railroad ties, fuelwood, cooperage, and mine timbers. Lumber is the outstanding use in both amount and value. Much of it is remanufactured into flooring, furniture, motor-vehicle parts, car construction, general millwork, and boxes and crates. Other uses that consume smaller amounts of lumber include caskets and coffins, ship and boat building, nonmotor vehicles, agricultural implements, fixtures, woodenware and novelties, and handles. Of the lumber not remanufactured, a large proportion is used in building construction and some is exported.

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[7] Refers to heartwood. The sapwood of all species is low in resistance to decay.

[8] The extract called "quercitron" obtained from black oak is essentially a dyestuff and not a tanning material.

The hardness and wearing qualities of oak, combined with handsome appearance and ability to stay in place, have made it the principal flooring wood for residences. For striking effects, quarter-sawed flooring is used; for more subdued effects, plain-sawed material is preferable.

Oak is one of the oldest furniture woods. Its abundance, hardness, strength, machining properties, and appearance, as well as its adaptability to various kinds of finish, qualify it well for all grades of furniture. In 1948 the leading furniture wood, from the standpoint of quantity used, was yellow-poplar, followed closely by sweetgum. Oak ranked third, having more than doubled in use since 1940.

Oak is the leading wood in the construction of motor vehicles, but the amount has decreased markedly in recent years as more metal has been substituted. Oak has been a preferred wood for ship and boat construction ever since the days of England's "wooden walls"—a term applied to ships of oak built for the British Navy. The first forest land reserved by the U.S. Government consisted of an island in the Gulf of Mexico that contained a stand of live oak especially suitable for ship "knees."

Oak has always been a leading wood for railroad ties.[9] In 1955 about 14.4 million ties, or 54 percent of all crossties treated, were of oak species. From 1947 to 1956, an average of 15.9 million oak crossties were treated annually. The white oaks are sometimes used without preservative treatment, while the less durable red oaks are nearly always treated.

TABLE 4.—*Oak used in the manufacture of wood products*

(Thousands of board feet)

| Product | 1912 | 1928 | 1933 | 1940 | 1948 |
|---|---|---|---|---|---|
| Airplanes | 4 | 7 | 10 | 7 | 7 |
| Agricultural implements | 69, 346 | 23, 798 | 3, 536 | 9, 121 | 16, 134 |
| Boot and shoe findings | 3 | ---------- | ---------- | 188 | ---------- |
| Boxes (cigar and tobacco) | 403 | 17 | 2, 493 | 46 | ---------- |
| Butchers' blocks | [1] 12 | ---------- | ---------- | ---------- | 108 |
| Car construction and repair | 305, 277 | 139, 648 | 31, 857 | 46, 972 | 44, 499 |
| Caskets and burial boxes | 7, 544 | 11, 800 | 6, 435 | 8, 352 | 14, 163 |
| Conduits, pumps, wood pipe | 566 | ---------- | ---------- | 1 | ---------- |
| Containers (except cooperage) | [2] 56, 362 | [2] 68, 218 | 38, 954 | 208, 962 | 58, 806 |
| Crossarms | ---------- | ---------- | ---------- | ---------- | [3] 9 |
| Dairy, poultry, other supplies | (4) | 679 | 725 | 597 | 57 |
| Dowels, skewers, wedges | [5] 77 | [5] 900 | ---------- | 64 | 160 |
| Electrical equipment | 4, 936 | 1, 879 | 150 | 177 | 892 |
| Fixtures | 62, 682 | 21, 318 | 2, 946 | 6, 614 | 25, 363 |
| Flasks | [6] 182 | [6] 452 | 716 | 592 | [7] 640 |
| Flooring | (8) | (8) | 155, 347 | 946, 395 | 708, 200 |
| Furniture | 566, 327 | 148, 279 | 79, 877 | 98, 380 | 315, 319 |
| Grain doors | ---------- | ---------- | ---------- | ---------- | [9] 757 |

See footnotes at end of table.

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[9] Sawed ties are classed as lumber and are included in the lumber production figures.

Table 4.—*Oak used in the manufacture of wood products*—Continued

(Thousands of board feet)

| Product | 1912 | 1928 | 1933 | 1940 | 1948 |
|---|---|---|---|---|---|
| Handles | 12, 954 | 3, 948 | 3, 246 | 3, 020 | 9, 398 |
| Housetrailers | ---- | ---- | ---- | ---- | [10] 1, 603 |
| Instruments (musical) | 20, 638 | 2, 340 | 200 | 240 | 7, 021 |
| Instruments (professional and scientific) | 372 | 291 | 46 | 317 | 896 |
| Ladders | (4) | (4) | 17 | 141 | 1, 014 |
| Laminated structural members | ---- | ---- | ---- | ---- | [3] 195 |
| Laundry appliances | 427 | 345 | 247 | 202 | 806 |
| Machinery | 21, 579 | 604 | 47 | 327 | 1, 015 |
| Millwork | [11] 520, 052 | [11] 802, 410 | [12] 17, 711 | [12] 38, 181 | [12] 42, 740 |
| Pallets | ---- | ---- | ---- | ---- | [13] 43, 604 |
| Patterns | (14) | (14) | (14) | (14) | [7] 524 |
| Plumbers' woodwork | 14, 031 | 4, 507 | 1, 049 | ---- | 36 |
| Prefabricated houses and house panels | ---- | ---- | ---- | ---- | [3] 195 |
| Prefabricated structures (except houses) | ---- | ---- | ---- | ---- | [3] 632 |
| Printing material | 272 | 8 | 19 | ---- | 98 |
| Radios, phonographs, sewing machines | [15] 19, 106 | [15] 2, 757 | 1, 752 | 638 | 17, 955 |
| Refrigerators | [16] 31, 351 | [16] 20, 129 | 1, 091 | 935 | 3, 109 |
| Rollers (shade and map) | 294 | 57 | ---- | 327 | ---- |
| Ship and boat building | 32, 382 | 17, 154 | 6, 204 | 15, 451 | 15, 940 |
| Shuttles, spools, bobbins | 39 | 2 | ---- | 73 | 1, 089 |
| Signs, scenery, displays | 12 | 112 | 159 | 4 | 1, 150 |
| Sporting equipment (athletic and playground) | 5, 074 | 2, 118 | 331 | 287 | 825 |
| Surgical supplies | ---- | ---- | ---- | ---- | 420 |
| Tanks | 5, 042 | 256 | 936 | 326 | 361 |
| Toys | 1, 444 | 407 | 262 | 606 | 2, 338 |
| Trunks and valises | 4 | ---- | 3 | 44 | 5 |
| Vehicles (motor) | (17) | 106, 025 | 86, 355 | 38, 434 | 59, 769 |
| Vehicles (nonmotor) | 212, 918 | 27, 047 | 6, 101 | 7, 014 | 7, 618 |
| Woodenware, novelties, miscellaneous | 11, 872 | 1, 244 | 502 | 3, 520 | 9, 707 |
| Total | 1, 983, 584 | 1, 408, 756 | 449, 324 | 1, 436, 555 | 1, 315, 177 |

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[1] Includes skewers.

[2] Does not include oak used for containers by plants not classified as manufacturers of wooden products and included in later surveys.

[3] Included in "Millwork" in earlier reports.

[4] Included in "Woodenware and novelties."

[5] Includes dowels only.

[6] Does not include oak used for flasks and patterns by plants not classified as manufacturers of wooden products and included in later surveys.

[7] Flasks and patterns combined in earlier reports.

[8] Included in "Millwork."

[9] Included in "Car construction and repair" in earlier reports.

[10] Included in "Vehicles (nonmotor)" in earlier reports.

[11] Includes planing mill products such as flooring, siding, and ceiling.

[12] Planing mill products not included as in 1912 and 1928.

[13] Included in "Containers" in earlier reports.

[14] Included in "Flasks."

[15] Radio and phonograph cabinets included in "Furniture."

[16] Includes kitchen cabinets.

[17] Included in "Vehicles (nonmotor)."

In addition to lumber, substantial volumes of oak are used for other products. In 1952, for example, about 92 million board feet of logs, many of white oak, were consumed in the manufacture of tight cooperage. An additional but undetermined volume went into the manufacture of slack cooperage. White oak is the outstanding wood for tight barrels, kegs, and casks for whisky, beer, and wine. The flavor and palatability of whisky and wine are improved by storage in oak barrels, for which no satisfactory substitute has as yet been found. In 1953, about 10 percent of the hardwood veneer produced in the United States came from oak species. The availability and strength of oak have made it the leading wood for mine timbering, though consumption for this purpose has decreased in recent years. Fenceposts and piling are among other products derived from oaks.

Table 4 gives the amount of oak lumber used in the manufacture of wood products for the years 1912, 1928, 1933, 1940, and 1948, including material in the form of lumber, veneer, and logs and bolts. Lumber makes up a major portion of the material, with much smaller amounts of veneer and some short logs and bolts. The short logs and bolts are not sawed into lumber but into squares and other forms of the approximate sizes needed for furniture or other wood products.

## PRODUCTION

The production of oak lumber in 1954 amounted to 3,451 million board feet and accounted for about 9 percent of the total lumber production in the United States (western oaks do not contribute significantly to the total annual oak-production figures). In 1953, production amounted to 3,339 million board feet. The average annual cut of oak lumber for the 10-year period, 1945 to 1954, was approximately 3,225 million board feet.

The production of oak lumber in 1869, the earliest year for which data are available, amounted to slightly more than 2 billion board feet. For the next 30 years, the cut increased and reached a peak of 4,553 million board feet in 1899. Since then oak lumber production, with considerable fluctuation during the various depression periods, has gradually declined (fig. 22).

The three leading States in the production of oak lumber from 1869 to 1899 were Indiana, Ohio, and Pennsylvania. By 1899 much of the oak timber in these States had been cut and the center of oak production began to move southward. In 1904 Tennessee, West Vir-

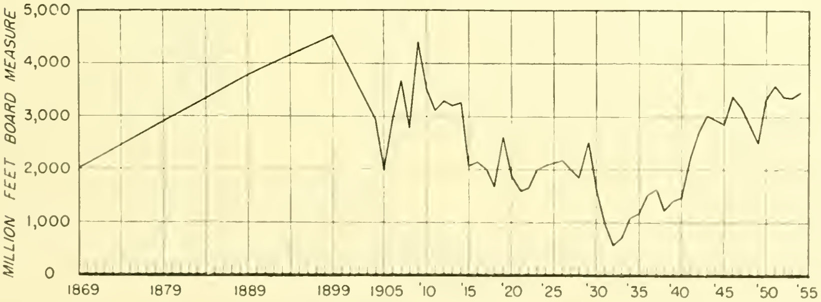

FIGURE 22.—Lumber production of oak (*Quercus* spp.), 1869 to 1954.

ginia, and Kentucky became the leading States and held that position until 1913, when Kentucky was displaced by Arkansas. From 1920 to 1929 Arkansas was first. Louisiana became one of the three leaders in 1924 and remained so until 1939, except in 1932 when it ranked fifth. The three leading States in 1954, collectively accounting for 25 percent of the total production of oak lumber, were Arkansas, Virginia, and Tennessee. Tennessee has been the most consistent producer of oak lumber, usually ranking among the first three since 1899.

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